

FINAL REPORT FOR NAGW-5126  
"The Interrelation of Soft and Hard X-ray Emission During Solar Flares"

Principal Investigator:

George H. Fisher  
Space Sciences Laboratory # 7450  
University of California  
Berkeley, CA 94720-7450

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The objective of this project is to determine the characteristics of flare energy transport processes through the study of soft X-rays, hard X-rays, and their interrelationships through analysis of Yohkoh SXT, HXT, and BCS data, and comparison with theoretical models. The personnel involved in the research include SSL Assistant Research Physicists Dr. Peng Li and Dr. James McTiernan.

This grant (NAGW-5126) is the first year of funding for a 2 year award. The 2nd year of funding is being administered as a new grant (NAG5-6128) from NASA-GSFC. This final report refers only to NAGW-5126.

Work Completed During the Past Year

We have concentrated on two projects. The first is a numerical model calculation of the spatially resolved behavior of the soft and hard X-ray emission from a solar loop. The loop plasma is assumed to be heated by the electrons which produce the hard X-rays, in the classic "chromospheric evaporation" model. We found that the spatially unresolved "Neupert Effect" holds for these models; however, the time histories of the soft X-rays at the top of the loop and the loops footpoints did not behave as expected, and were not consistent with Yohkoh observations. In order for the model predictions to be consistent with observations, the footpoint soft X-ray source may have to be nonthermal, excited by low energy electrons. Also continuous heating of the plasma at the top of the loop is required, in addition to that from energetic electrons. A paper describing the theoretical study, by Peng Li, James McTiernan, and A. Gordon Emslie has been accepted for publication by the *Astrophysical Journal*.

The other project involved the characterization of the Differential Emission Measure (DEM) of the soft X-ray plasma during flares. In our original work we used data from the Yohkoh SXT and GOES to obtain the approximate DEM for a number of flares, and used it to characterize the behavior of the flare plasma during the flare decay. Some of this data analysis was included in a paper by F.Reale *et al.* which will appear in *Astronomy and Astrophysics*. Analysis of Yohkoh BCS data has been added to this effort; results from this work were presented at the AAS/SPD meeting in Bozeman, MT in June, and a paper is being submitted to the *Astrophysical Journal*. (The results can also be found on the Web at <http://sprg.ssl.berkeley.edu/~jimm>.)

In other work, we have used Yohkoh BCS data in a study of the cutoff energy for non-thermal electrons. We determined that for a number of Yohkoh events, the emission above 14 keV (i.e., the low energy limit of the Yohkoh HXT) must be nonthermal. This work will be included in the Proceedings of the Yohkoh 5th Anniversary Symposium.

**Publications supported by NAGW-5126:**

- Li, P., McTiernan, J.M., and Emslie, A.G. 1997, "Theoretical Study of The Spatially Resolved Soft X-Ray Versus Hard X-Ray Relationship in Solar Flares", *Astrophysical Journal* in press.
- Li, P. 1997, "Recent Progress and Challenges in Solar Flare Physics", to appear in the *Chinese Space Physics Review*.
- McTiernan, J.M. 1997, "Limits on the Temperature of Impulsive Phase Solar Flare Hard X-ray Emission, and the Amount of Thermal X-rays Present in the Yohkoh HXT-LO (14-24 keV) Channel", to appear in the *Proceedings of the Yohkoh 5th Anniversary Symposium on OBSERVATIONAL PLASMA ASTROPHYSICS: FIVE YEARS OF YOHKOH AND BEYOND*.
- Reale, F., Betta, R., Peres, G., Serio, S., and McTiernan, J.M. 1997, "Determination of the Length of Coronal Loops from the Decay of X-ray Flares", to appear in *Astronomy and Astrophysics*.